Spacelabs Medical
An OSI Systems Company

Ambulatory Blood Pressure Monitor

90217/90217Q

Service Manual

070-0502-00 Rev. F

more time to care

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CAUTION:

Rx Only **US Federal law restricts the devices documented herein to sale by, or on the order of, a physician.**

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Introduction

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Overview

The Model 90217 is a small, lightweight battery-powered Ambulatory Blood Pressure (ABP) monitor that uses the noninvasive Oscillometric method to measure blood pressure and heart rate. This data is then stored into memory for later transfer to an ABP Analysis System (FT1000A/FT2000A or equivalent), a PC Interface, a Base Station, or a Report Generator for data analysis, report printing, and archiving.

The 90217 monitor is housed in a plastic case with a removable battery cover that provides access to its three AA cells. Inside the monitor are three printed circuit boards: the Main, Power, and Display boards.

Programming resides in an internal 128 KB RAM and microprocessor ROM. Most of the code exists in the RAM and can be updated via an infrared (IR) serial port located at the rear of the unit. The internal ROM contains a boot code and other codes for downloading and completing special tasks.

The IR serial port transfers collected data to a report generator and sends setup changes to the ABP monitor.

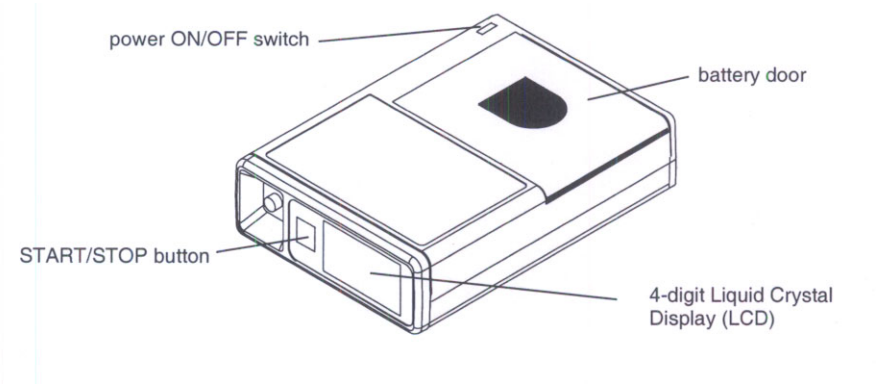
A rechargeable lithium battery keeps the RAM and real-time clock backed up during periods when the AA batteries are removed.

Note:

Beginning with August 2004 shipments, all 90217 models have a "Q" suffix, indicating a quick-disconnect fitting for cuffs. Prior versions had a Luer fitting. This manual includes information relating to both.

User Controls

The 90217 ABP monitor provides two user controls: a START/STOP button and a Power ON/OFF switch.



Power ON/OFF Switch

When turned ON, this switch activates the monitor and begins executing the timed blood pressure program.

START/STOP Button

This front panel control manually starts a blood pressure measurement, stops a measurement already in progress, or sets special modes of operation (refer to the *90207, 90217 Ambulatory Blood Pressure Monitors Operations Manual,* P/N 070-0137-xx).

Display

The monitor display is a 4-digit LCD that presents the following information (refer to the *90217 Ambulatory Blood Pressure Monitors*, *Operations Manual* (P/N 070-0137-xx) for instructions on use).

Systolic/Diastolic Pressure and Heart Rate

Patient information appears on the display sequentially with systolic first, diastolic next, and then heart rate. Each parameter appears for approximately one second. The screen is blanked for one second and the sequence of readings is re-displayed two more times.

A bar indicator at the left of the display identifies which parameter is currently being displayed. It appears next to the “sys” for systolic, next to “dia” for diastolic pressure, and next to the heart symbol for heart rate.

Time of Day

A real-time clock provides the time of day, which appears between measurement cycles and can be programmed in either a 12- or 24-hour mode.

Cuff Pressure

This pressure can be shown while the monitor is taking a measurement. If cuff pressure is not selected, "----" appears. Cuff pressure can be enabled or disabled in software.

Event Code

Event codes are 4-digit LCD messages that begin with "EC" or, in some cases, show specific codes such as "LLL" for a low battery. If enabled, a beep sounds during an event code and the code is displayed on the monitor. Refer *Troubleshooting* on page 5-1 for event code information.

Count Down Sequence

Whenever the monitor begins a measurement cycle, it turns its tone ON (if beep is enabled) and counts down from 5555 to 1111 on the display.

IR Communications

During IR communications, the monitor first displays **9999** on the LCD to indicate that it has detected a cable connect and has gone into the communication mode. The monitor periodically attempts to contact a modem. The left two digits on the monitor display indicate the steps in the communication process. For more information, refer to *Base Station via Modem* on page 2-3.

Programming Options

These monitor options are user programmed:

Day or Night Modes

Day mode = beeper ON, inflation time approximately 15 seconds

Night mode = beeper OFF, inflation time approximately 20 seconds

Measurement Intervals and Periods

Measurement intervals are selectable from 6 to 120 minutes (in one minute increments) for each period. It is also possible to not have readings taken during a specified period. Up to 12 periods may be defined.

Clinical Verification Mode

When set to this mode, the monitor is forced to bleed to 40 mmHg or to one step below diastole (whichever is lower) for each reading.

Office Check Mode

This mode verifies monitor operation and allows a user to view cuff pressure and blood pressure results regardless of any previous disabling of the display. During Office Check Mode, the monitor bleeds an additional pressure step below diastole.

This mode is enabled for the first five successful blood pressure readings (or attempted readings) following monitor initialization. Office Check can be disabled by a patient cancel and can be re-enabled after turning the power switch ON and holding the START/STOP button in while the last digit of the software version number is displayed.

Blood Pressure/Heart Rate Measurements Displayed

These measurements can be selected to appear or not to appear at the end of a measurement.

Cuff Pressure Displayed

This measurement can be selected to appear or not to appear during the measurement cycle.

Contents

Installing the Batteries

Two types of batteries are used in the 90217 ABP Monitor: three standard AA batteries (Spacelabs Medical P/N 146-5011-xx) to power the cuff air pump, and one rechargeable lithium battery to backup the clock and RAM circuits when the AA batteries are removed or are exhausted. This lithium battery receives its charge from the AA batteries and does not normally require replacement. Its expected life is at least nine years.

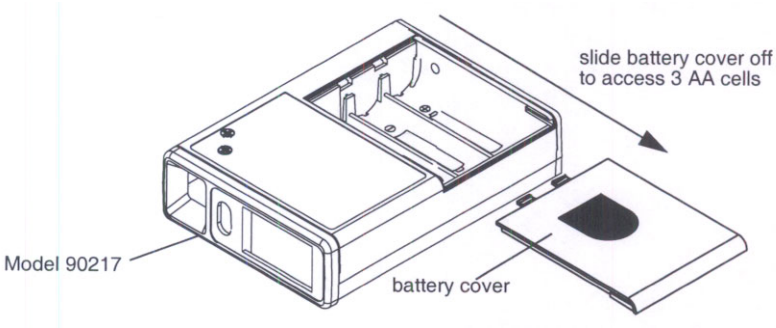
If alkaline batteries are used as the AA batteries, they must be replaced after each patient use. Nickel cadmium batteries require a full charge before each use.

AA Batteries

To replace the three AA batteries:

1 Switch the monitor's power switch to OFF.

2 Remove the battery compartment cover plate by sliding it to the right until it can be pulled free.



3 If present, remove the old AA batteries from the monitor and replace each with a fresh alkaline battery (or fully charged nickel cadmium), being careful to match polarities where indicated (**+** or **-**).

Note:

The monitor will not operate if batteries are incorrectly installed.

If the monitor is going to be stored longer than two weeks, remove the AA batteries to prevent the possibility of leakage or discharge. Spacelabs Medical is not responsible for product damage caused by battery leakage. If your unit has been damaged by a leaky battery, contact the battery manufacturer for any recoverable repair costs.

4 After correctly inserting the batteries, gently slide the battery cover back into place.

5 Switch the monitor ON and verify that the display appears. If there is no display, switch the monitor OFF and refer to in this manual. When power is first switched ON, the first four digits of the RAM code revision are displayed for about 1 second, followed by a blanked display, followed by the last two digits of the revision number.

Initializing the Monitor

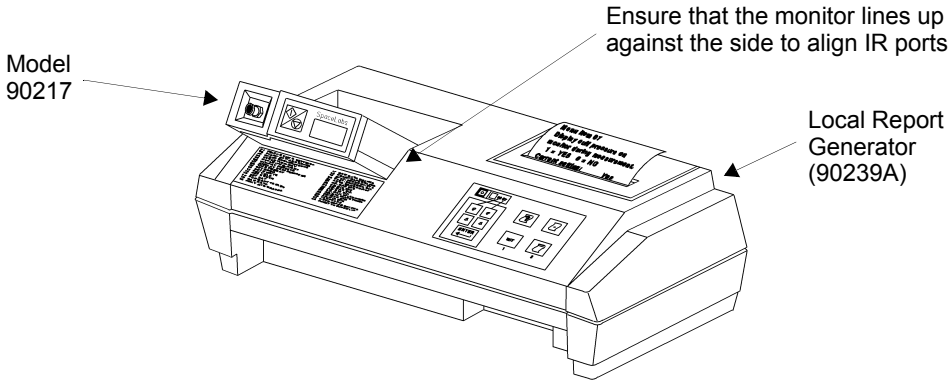
The ABP monitor must be initialized prior to use. Initialization specifies the monitoring period, patient information, time format, measurement interval, monitor tone ON/OFF during selected periods, event code display, and whether or not to display pressure values. To initialize the monitor, connect it to one of the following analysis systems.

If using 90121 or 92506 products, refer to the appropriate Operations manual for setup and operation.

Local Report Generator

For a direct connection to a Local Report Generator, place the monitor into the chute on the Report Generator (Model 90239A or equivalent):

Local Report Generator Direct Connect Configuration

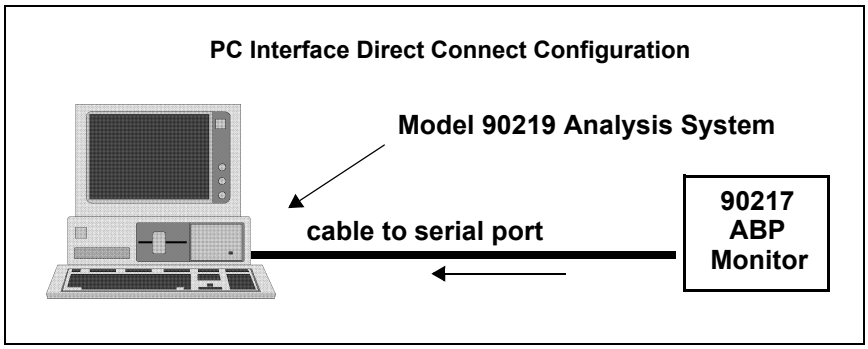


PC Interface

For a direct connection to an IBM XT/AT/PS2 (or equivalent) via a Model 90219-02/90219-03 (or equivalent):

1 Connect the ABP monitor to the 90219 Analysis System.

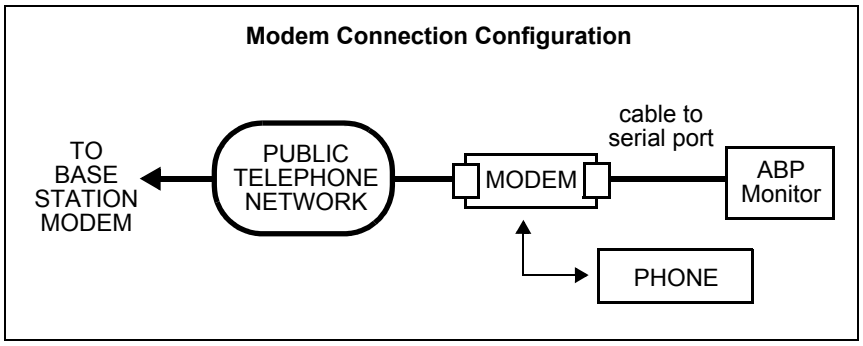
2 Connect the 90219 Analysis System cable from the monitor to the serial port on the PC.



3 Refer to the *90219 Ambulatory Blood Pressure PC Interface/Base Station Operations Manual* (P/N 070-0238-xx) for instructions for operating the Analysis System.

Base Station via Modem

For a modem connection to a remote IBM XT/AT/PS2 (or equivalent) base station:



Note:
The initialization procedure is provided in the 90219 Ambulatory Blood Pressure PC Direct/Base Station Operations Manual (P/N 070-0238-xx).

1 The 90217 can use one of the following modems for communication:

- Hayes Smartmodem 1200
- Hayes Optima 9600 or equivalent
- Most 2400 baud modems

If the remote site also has 90202 or 90207 monitors, a Hayes Smartmodem 1200 must be used with those monitors.

High speed modems are set up via software commands.

The Hayes Smartmodem 1200, which attaches to the monitor, must be set up as follows:

Switch #	Setting at Monitor Site
1	down
2	up
3	down
4	down
5	down
6	up
7	up
8	down
9	up
10	up

2 Connect the serial port cable (P/N 012-0096-xx) between the monitor and the modem.

Note:
If call waiting or call forwarding are options on the telephone used to transfer data, ensure that both are deactivated or modem communications may be interrupted. In addition, telephone systems, such as CBX or PBX, can cause interference with the modem, or the modem can cause interference with the switching system.

To initialize the monitor for a remote connection:

1 Contact the base station by telephone (for remote operation only).

2 Ask the base station operator to initialize the monitor. Give the following information to the operator:

- Patient's name.
- Patient ID number.
- If the monitor display is to be active or inactive.
- Time of day (12- or 24-hour format).
- If measurements are to be displayed (systolic/diastolic and heart rate).
- Multiple or single cycle times. If using a single cycle for the 24-hour monitoring period, indicate the cycle interval and whether the tone is ON or OFF. For multiple cycle time, specify each cycle interval and whether the tone is ON or OFF for each cycle.
- Any other information the base station operator may request.

3 The base station operator enters the patient information in the computer.

4 Prepare the monitor to receive the patient data from the base station.

- Switch the modem ON.
- When instructed by the base station operator, switch the ABP monitor ON.

Note:
The modem link must be established within 45 seconds for the 90217. If this does not happen, switch the monitor OFF and return to step 1.

5 When the information transfer is complete, the ABP monitor beeps and voice communication is restored.
- Switch the monitor OFF and disconnect it from the modem.
- If there is a direct connection between the monitor and the base station, switch the monitor OFF and disconnect it from the ABP data interface unit.

To transfer readings from the monitor to the base station:

1 Contact the base station by telephone (for remote operation only).

2 Ask the base station operator to read the monitor. Give the following information to the operator:
- Patient's name.
- Patient ID number.
- Any other information that the base station operator may request.

3 The base station operator enters the patient information into the computer. (If the monitor is in a remote location, the operator must turn power to the base station modem ON.)

4 Prepare the monitor to transfer data to the base station.
- Switch the modem ON.
- When instructed by the base station operator, switch the ABP monitor ON (for remote operation only).

Note:
The modem link must be established within 45 seconds for the 90217. If this does not happen, switch the monitor OFF and return to step 1.

5 When the information transfer is complete, the ABP monitor beeps and voice communication is restored.
- Switch the monitor OFF and disconnect it from the modem.

Modem Indicator Lights

When the monitor is switched ON, the modem's RD (receive data) and SD (send data) lights flash for several seconds. The OH (on hook) indicator is lit when the monitor starts communicating with the remote modem. When both modems connect, the CD (carrier detect) is lit. The SD and RD lights flash as data is being transferred.

After the transmission is complete and the monitor is turned OFF, the HS, TR and MR indicators will always remain lit at the local modem.

90217 Modem Connection Status Indications

The left-most digit of the 90217 display shows the various stages of the modem connection process:

1 Sending modem identify query.

2 Waiting for response to identify query.

3 Sending modem reset commands.

4 Sending modem setup commands.

5 Send off-hook command.

6 Waiting for contact.

7 Contact established.

9 Not attempting to contact modem.

Once contact has been established, the second digit from the left on the 90217 display indicates the baud rate of the connection. On high speed modems, the indicated speed refers to the connection between the ABP monitor and the modem. The two modems may be communicating at some speed other than that at which the modem is communicating with the monitor.

The baud rate codes are as follows:

0 1200

1 not used

2 2400

3 4800

4 9600

5 19.2 k

6 38.4 k

Setup Test

Note:

Verify that all cable connections are installed correctly and are connected securely.

Switch the ABP monitor ON. It initially displays **9999**. When the monitor is being read or initialized, these digits change to indicate that communication is taking place between the monitor and the analysis system. When communication is complete, the digits stop changing.

The right-most digit indicates that a message has been sent from the monitor to the base station. The second digit from the right indicates that a non-garbled message has been received by the monitor. A common failure mode is with only the right digit spinning. This indicates garbled messages are being received and an “I don’t understand” response is being transmitted by the monitor.

Operational Tests

Conduct the following procedures to verify proper operation of the 90217 ABP Monitor.

Equipment Required

- 90219-02 system
- 90219-03 ABP Base Station software
- Type AA alkaline batteries (3)
- Cable, 90217 to PC, P/N 012-0097-xx (greater than -02)
- Setup for air leaks (refer to *Air Leak Test* on page 2-8)
- Analog manometer (optional)
- Stop watch or equivalent
- Battery spring insertion tool, P/N 003-0084-00

Visual Inspection

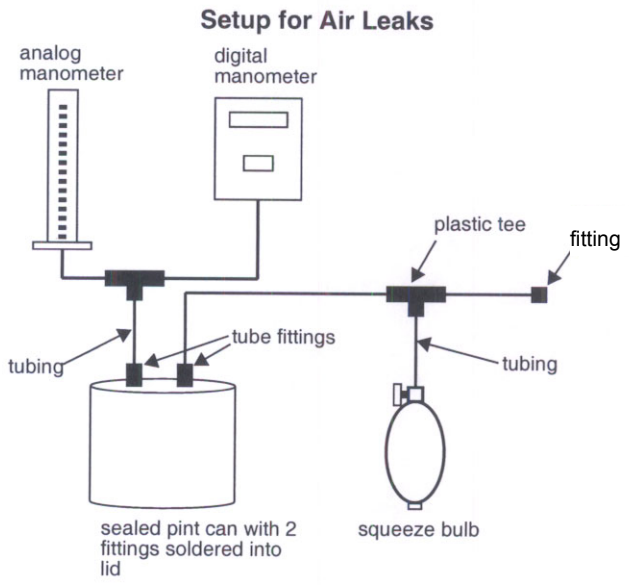
1. Check the display window and ensure that it is clear (free from scratches, contamination, etc.) with the words **SYS DIA** appearing on the left side.
2. Verify that the front panel START/STOP button responds with a clear “snap” when pressed.
3. Inspect inside the battery compartment to ensure that the battery springs are clean and provide a good electrical contact with the batteries.
4. Install the three AA batteries and verify that the battery door closes and latches properly.

Air Leak Test

1 Connect the test setup illustrated below.

Note:

This figure shows the use of both an analog and digital manometer. Both or either can be used in these tests. If only one manometer is used, block off the unused hose.



2 Close the squeeze bulb valve.

3 Turn ON the 90217 and press the START/STOP button.

4 Verify the following monitor response:

- Two beeps are sounded.
- The display counts down: 5555, 4444, 3333, 2222, 1111.
- Pumping begins and "_ _ _ _" is displayed (could display the pump pressure, depending upon how the monitor was initialized).

5 Verify that the system pumps up to 165 mmHg, ±8 mmHg, before the pressure begins to drop in 7 to 9 mmHg steps. Ensure that the pressure does not drift down.

Note:

It may take 3 or 4 steps before the cuff size is learned by the monitor and the steps fall within this range.

6 Verify that the display reads **EC18**.

7 Open the bulb valve and remove the monitor from the manometer setup.

PC Interface Test

Note:
The PC Inferface Test is only applicable for use with a PC System that operates with the 90219 software.

1 Connect the system as illustrated:

2 Power ON all devices.

3 Start the 90219-03 Base Station software (loaded on hard drive).

4 Type: **ABP** (or ABPPCI) and press the **Enter** key on the base station.

Note:
If the file name has been changed from ABP, type DIR and press Return to determine the new name.

5 Switch the 90217 power switch ON.

6 Press (in this order):

Space Bar

1 (ABP communication)

3 (direct connect - skip this step if a PC Interface data key is attached instead of a base station data key)

2 (read ABP unit)

7 Press any key (wait).

8 Type **8**, press the **Enter** key, and type **Y** (yes).

Note:
"8" is the name of a dummy file, which should be setup on the computer already.

9 Press the **END** key.

10 Verify that the clinical data appears on the computer screen. The last reading on this screen is the results of the test done earlier in these procedures.

11 Verify that the date and time are correct and that the event code **EC18** appears.

12 Press the **ESC** key.

13 Initialize the 90217 by typing:

1 (initialize ABP)

14 Press the **END** key and use the **up arrow** key until PATIENT NAME is selected.

15 Type:

TEST and press the **Enter** key

1234567890 and press the **Enter** key

NONE and press the **END** key

16 Verify that the display reads **"***MONITOR INITIALIZED***"**.

17 Press:

Space Bar

ESC key

ESC key

ESC key

Y key (yes)

18 Remove the 90217 from the system and switch power OFF.

19 Remove one AA battery.

20 Wait one minute and reinstall the battery.

21 Switch ON 90217 power and verify that the time remained correct.

Contents

Pressure Amplifier

The pressure amplifier monitors the voltage produced across the pressure transducer. This voltage is proportional to the pressure in the arm cuff.

The pressure transducer circuits require temperature compensation to account for changes in sensitivity. This is accomplished by using a reference current to provide a constant current source into the bridge. Any change in bridge resistance due to temperature will change the bridge voltage in an amount that compensates for any change in sensitivity.

Voltage across the transducer is amplified differentially and turned into a single ended voltage that is amplified, offset and sent to the processor's A/D converter, the oscillometric amplifier and the overpressure detector.

Offset Adjust

Both transducer offset and operational amplifier offset are nulled out using a pressure offset adjustment. Minor variations in the offset are tracked and compensated for in software.

Gain Adjust

Changes in gain are compensated for with a gain adjustment. The voltage gain to the A/D converter is +15 mV/mmHg, and the voltage is offset by approximately 0.09 volts. This 0.09 volts is inserted to prevent the A/D converter signal from going negative during drifts in the offsets. The 0.09 volt offset is subtracted in software.

Oscillometric Amplifier

Gain, Offset, and Filtering

The oscillometric amplifier is DC coupled. A D/A converter provides large amounts of DC offset to the amplifier to prevent the large static pressure component of the waveform from over driving the amplifier. It provides gain (x64), DC offset, and high frequency filtering (3dB point = approximately 80 Hz). The oscillometric filtering that was present in earlier designs is now done by software.

RAM Protect and Reset Circuit

When the +5 volt power supply begins to drop, the RAM protect circuit asserts a reset signal to the processor that protects RAM data during power collapse. This same circuit provides a start up processor reset signal at power up. Reset time is a product of the reset R-C time constant and the hold off time necessary for the power converter to reach +5 volts (the reset time constant is 350 msec).

A/D Voltage References

The A/D reference (+ADR) is generated from a LM4041-1.2 band gap reference. Its reference output of 1.2 volts is amplified to 4.608 volts by a gain adjustable amplifier (+ADR = +4.608 volts, adjustable).

30 Second Pulse

The real-time clock produces a pulse every minute with a 30 second duration. This pulse's leading and trailing edges are conditioned into separate pulses and applied through a diode to the processor's WAKE_UP line to awaken it every 30 seconds.

Second Pulse

The SECONDS line goes to the LCD where it blinks the colon and changes the LCD polarity.

Cable Connected

If a cable is connected to the RS-232 communications connector with the power switch ON, the power converter activates and awakens the processor. A cable connected condition prevents the power converter from going down as a result of a shutdown fault generated by the watch dog timer, but cannot prevent an over-pressure shutdown. Once a cable has been connected, the processor goes into a listening mode, awaiting instructions from the RS-232 port.

These instructions adhere to the ABP communications protocol.

Watch Dog Timers

The watch dog timers ensure that the cuff cannot remain inflated because of a software crash. There are two watch dog timers in the Model 90217: one resides inside the processor; the other inside the real-time clock. Each counts 180 seconds before timing out. Both timers start at converter power up.

The real-time clock watch dog timer triggers the hold off that disables the pump, opens the bleed valve, and informs the CPU of its action. In 16 seconds after the hold off is asserted (if the software does not end the reading) fault shutdown resets the system. The hold off is also asserted at the end of every reading. The hold off always stays active for 32 seconds or until a manual reading is started.

Fault Shutdown

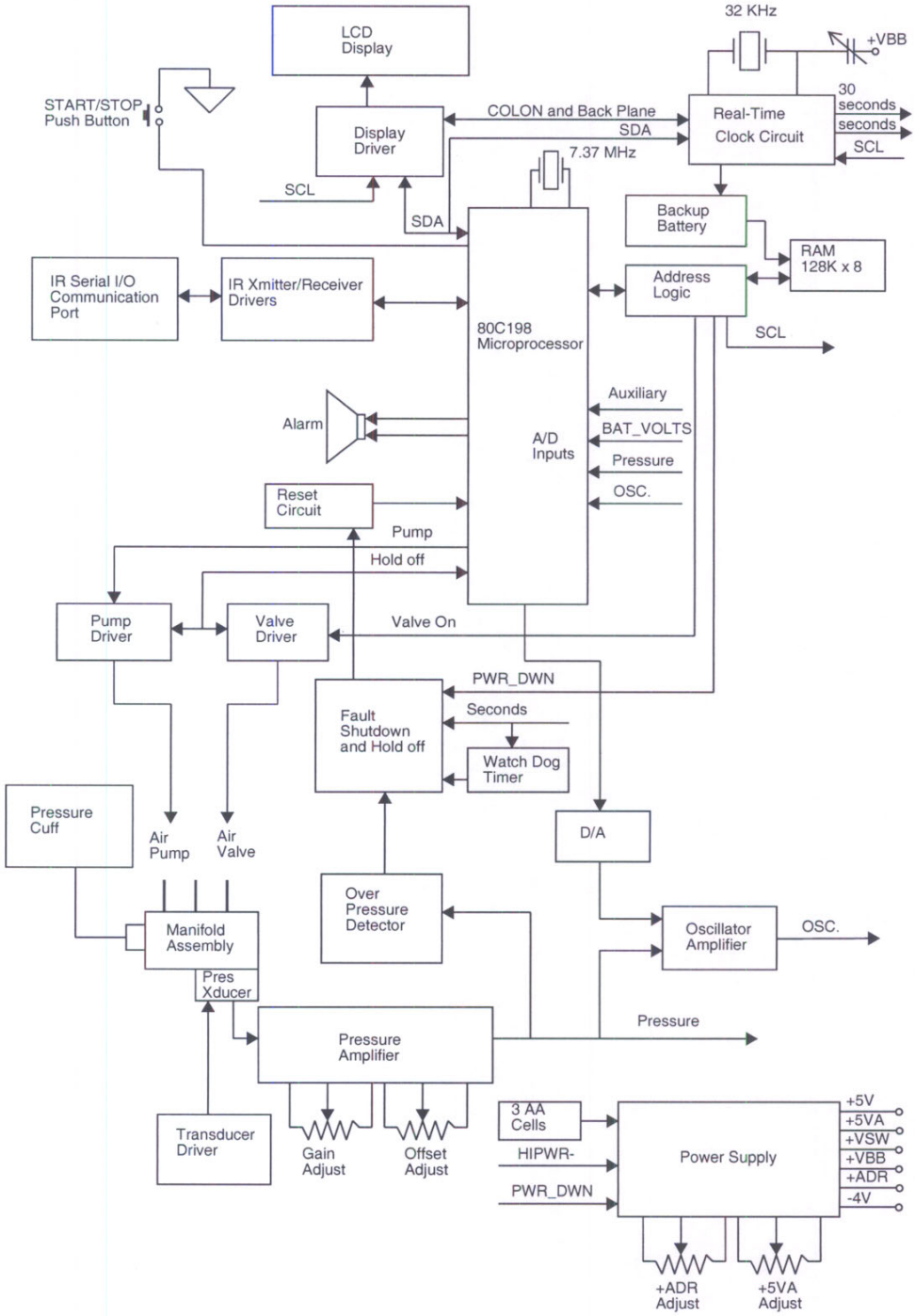
The fault shutdown circuitry resets the system because of two conditions:

- There is an over-pressure condition not detected by software.
- Pressure reading takes longer than 180 seconds (this indicates a software crash since a software time out should have already stopped the reading).

Over-Pressure Detector

In addition to software over-pressure detection, there is also a hardware over-pressure detector that activates at approximately <295 mmHg. A one-half second delay in initiating an over-pressure response prevents motion artifacts from causing a false over-pressure detection.

90217 Block Diagram



Digital Circuitry

Display Board

Information is sent from the processor to the LCD controller via a serial bus (CBUS). The LCD controller activates the necessary segments to display information on the 4-segment LCD. Each of the segments can be controlled separately. The processor determines which segments must be turned ON and sends this information to the controller.

An exclusive OR gate blinks the colons once per second when in the clock mode and also changes drive polarity.

Real-Time Clock

The real-time clock sends and receives data via a bidirectional serial bus that goes to the processor. The clock is backed up by the 3-volt lithium cell when the main batteries are removed. The clock uses an adjustable 32 KHz crystal.

RAM

A 128 KB x 8 RAM stores patient collected information, programmed information, and RAM code software execution. RAM is backed up by the 3-volt lithium cell during main battery removal.

Addressing and Control

Addressing and control are accomplished using a combination of processor ports, latches, and gates.

Communications RS-232 Connector

The communications connector is a modified RS-232 interface. When the communications cable (IR cable) is connected to the back of the unit, a reed relay activates the monitor if the power switch is turned ON.

At this point, the processor checks and determines that the C_CON cable connected line is asserted and goes into the communication mode. The processor determines whether the cable is communicating with a modem or a report generator and responds accordingly.

Communications are done using two lines: transmit and receive. Data is converted into IR signals in the cable and ABP monitor.

Processor

The processor type is an 80C198 with a 7.37 MHz crystal. It contains on-board RAM, ROM, A/D converter, data ports, addressing control, serial bus lines, and modulator ports that control motor speed and speaker outputs.

The on-board ROM contains routines for communication and start up. The majority of the ABP monitor's program is loaded into RAM using the infrared RS-232 port.

Unit Power

All power for the 90217 ABP Monitor comes from the main batteries (3 AA cells) and the rechargeable 3-volt lithium battery.

Unregulated Power Supplies

+VSW

The switched battery voltage (+VSW) is provided by the main batteries via the unit power switch. With this switch ON, +VSW is applied to the power converter, the air pump, and to the various circuits, which must remain active during the processor idle down mode.

+VBB

The backup battery supply (+VBB) is always a diode drop (0.3 volts) down from the main battery voltage (+VSW), the +5, or the lithium battery voltage, whichever is the highest.

- If the power switch is OFF and there are charged main batteries in the unit, the main batteries supply the voltage through a diode (+VBB will be approximately 3.3 to 4.5 V).
- If the power switch is ON and the +5 V supply is higher than +VSW, the power comes from the +5 V supply through a diode (+VBB is approximately 4.6 to 4.8 V).
- If the main batteries are removed, the voltage is developed from the lithium backup battery through a diode (+VBB is approximately 3 V).

Power Converter

The power converter is a MAXIM “MAX655” step-up converter. It develops the +5 V supply from the main battery voltage, which ranges from 2.5 to 4.8 VDC.

Low and High Current Modes

When the power converter is in its low current mode, it draws 40 μamps of quiescent current.

The power converter goes into a high current mode upon receiving an interrupt from any of its three wake-up sources: cable connect, clock, or START/STOP button. A 5 msec delay following a wake-up signal keeps the power converter in high current mode while the processor wakes up and asserts the PWR_HI line.

The power converter develops the +5 V supply, the +5 VA supply, and the converter reference voltage, ONNV_VREF.

+5 V Supply

The +5 V supply is developed directly from the +VSW (main batteries and is regulated to +4.75 to +5.25 volts). The maximum current available is 60 ma (typical draw is approximately 20 ma).

+5 VA Supply

+5 VA is a secondary power source for the analog circuitry. It can be disconnected to reduce power consumption when the analog circuits are not being used by asserting the PWR_DWN line.

CONV_VREF

The converter reference (CONV_VREF) is created by a band gap reference (about 1.25 volts) to produce +5 volts (adjusted to + 5 volts) at the +5 VA supply.

Backup Battery Circuit

A 3-volt rechargeable lithium cell provides backup power to the clock and RAM circuits when the main batteries are removed or exhausted. This lithium battery receives its charge from the three AA batteries and has a 20 - 35 ma/hrs capacity with sufficient charge to last approximately 4 months without the main batteries installed.

Main Battery

The main battery voltage is monitored by reading the BAT VOLTS line with the A/D converter. The voltage at this point is a divided down sample of the +VSW voltage.

Wake-up Interrupt

The power converter is activated when one of its three wake-up sources generate an interrupt and trips the 5 msec one-shot. The microprocessor must assert the PWR_HI line during this 5 msec period to place the power converter in its high power mode.

Three sources can place the power converter into high power mode:

- An RS-232 serial cable is connected

  This cable connect is detected when the reed switch is activated by an external magnet. When the reed switch closes, it causes an interrupt to the processor on the WAKE_UP line.
- A clock wake-up

  The real-time clock produces an output that changes state every 30 seconds. These transitional states are shaped into pulses that create interrupts to the processor.
- The START/STOP button is pressed

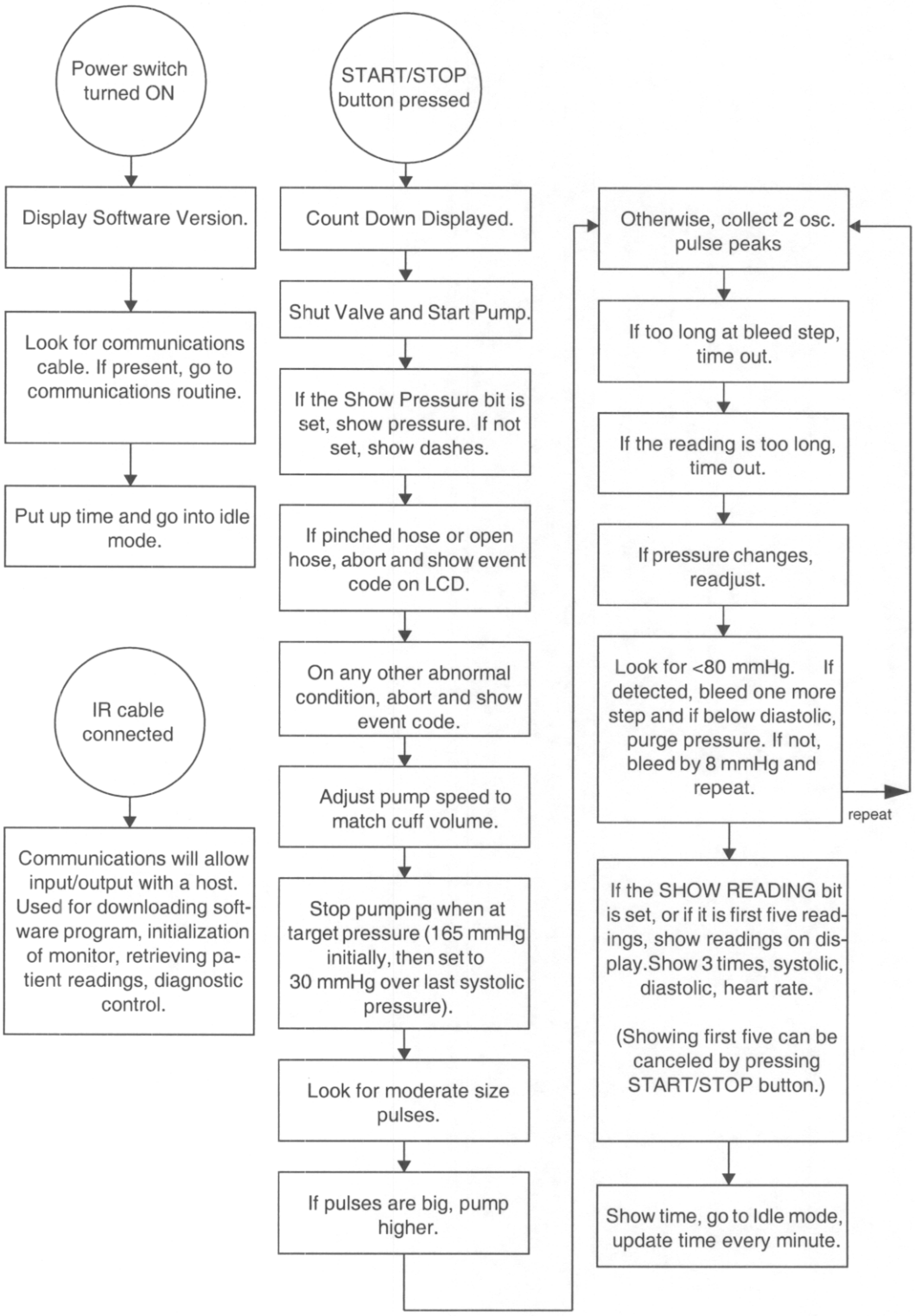
  When the START/STOP button is pressed, the WAKE_UP line is asserted.

Once an interrupt request has gone to the processor by asserting the WAKE_UP line, the processor looks to see which of the three sources asserted the WAKE_UP line.

Power Switch

When the power switch is ON (closed), the +VSW supply comes up and provides power to all the circuitry in the ABP unit. The +VBB supply receives power directly from the main batteries to ensure that the lithium battery will not be drained when main batteries are available.

Software Flow Chart



Maintenance

Contents

Periodic maintenance consists of cleaning the unit, replacing or recharging the batteries, testing the unit for accurate operation, and calibrating when necessary.

Cleaning

Use a soft, damp cloth and mild detergent mixed with water to wipe the exterior of the monitor. Clean the carrying pouch and air hose with isopropyl alcohol.

The cuff wrap may be sterilized only with ethylene oxide (ETO) sterilization methods using standard hospital procedures. Use standard aeration techniques after sterilization. Small soiled or stained areas may be cleaned by gentle scrubbing with a sponge or cloth soaked in a mild soap and water solution.

The cuff wrap with the air bladder removed is machine washable on “delicate” cycle only. Do not wash with bed linens, gowns, or in large commercial-type washers.

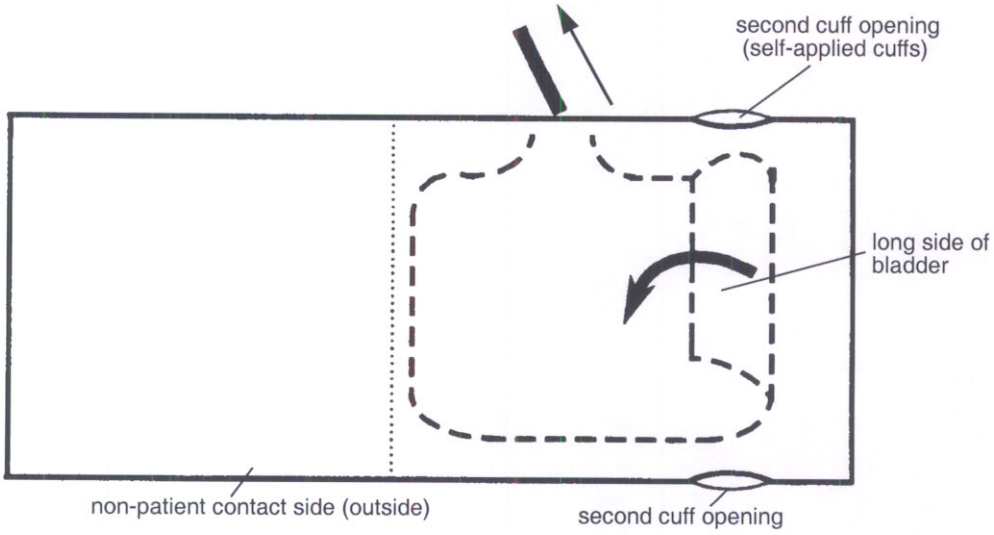
To remove the bladder for cleaning, refer to the figures below and follow these steps:

1. Using your fingers only, fold or roll up the bladder inside the cuff. Do not use pencils, pens, or other hard objects as damage to the bladder could easily occur.
2. Remove the bladder through the hose exit opening. Once the bladder has been removed, be sure to attach the hook and loop surfaces on the cuff before washing.
3. After washing and drying the cuff, reinstall the bladder in the reverse order of its removal. Make certain that all folds in the bladder are removed prior to inserting it back inside the cuff.

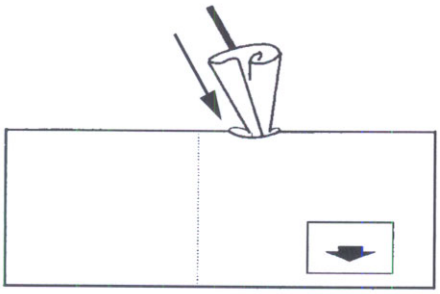
Note:

The bladder may be installed with the hose exiting the second cuff opening. However, the bladder must be positioned with its long side toward the center of the cuff.

Air Bladder Removal



Air Bladder Reinstallation



Calibration Check

To verify calibration of the 90217 ABP Monitor:

1. Obtain a full-size mercury sphygmomanometer (manometer) or aneroid gauge.
2. Disconnect the cuff hose from the monitor.
3. Connect the T-tube splitter to the monitor pneumatic connector and the sphygmomanometer.
4. Wrap the pressure cuff around the rigid cylinder, and fasten the cuff. Connect the cuff hose to the remaining connection on the T-tube splitter. Refer to *Figure 4-1* for the test setup.

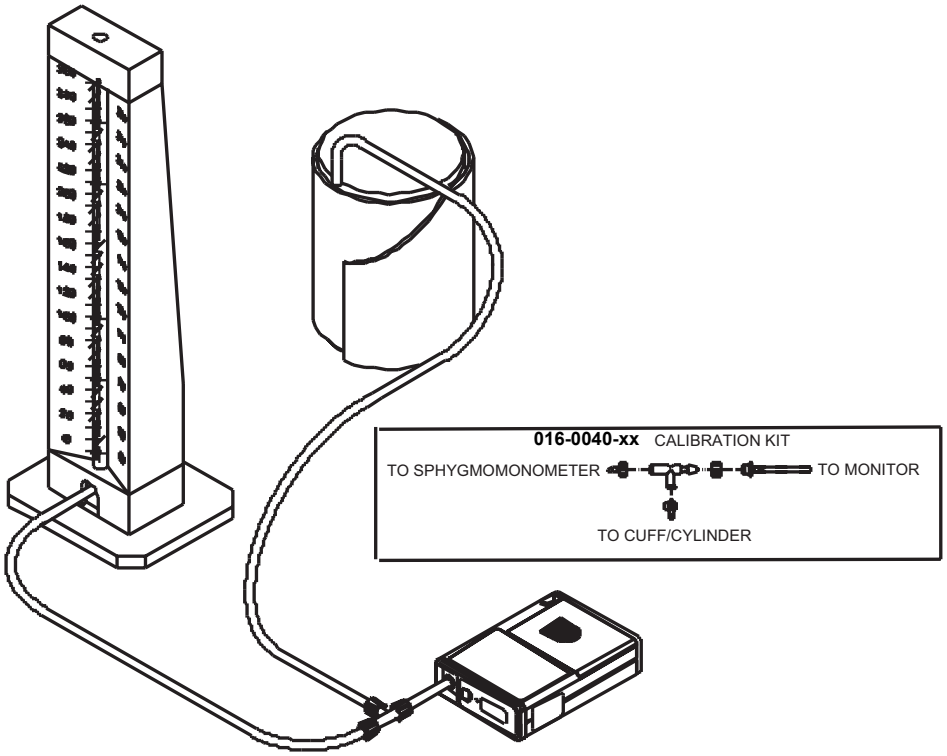
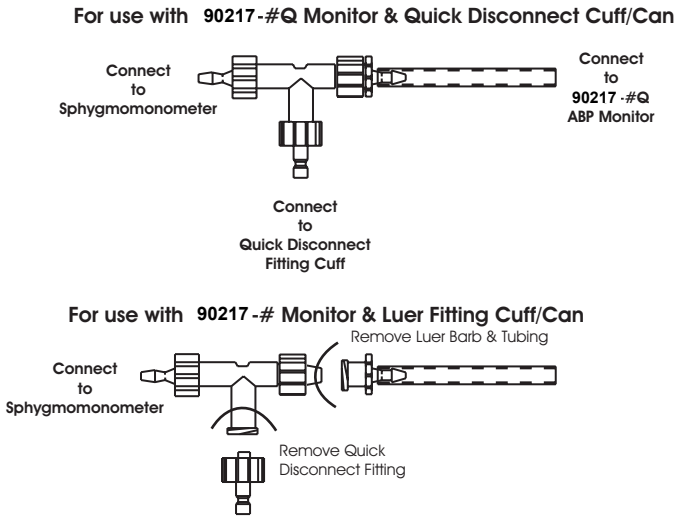


Figure 4-1: Connection to Sphygmomanometer



5 Press the **START/STOP** button on the front of the monitor. After the pump has stopped, the monitor display should read approximately 165 mmHg (only if the START/STOP button has been operated since the last measurement; otherwise it should read 35 mmHg above the average of the last five readings). Compare the readings on the monitor and the manometer while the pressure bleeds down. The monitor reading should be within three millimeters of the manometer reading or 2% of the reading, whichever is greater (± the accuracy of the manometer). At the end of this procedure, the monitor will display an event code.

6 Disconnect the T-tube splitter from the monitor. Disconnect the air hose and sphygmomanometer from the T-tube. Re-connect the cuff to the monitor.

Calibration Procedures

The following procedures allow field testing and calibration of the Model 90217 ABP Monitor.

Equipment Required

- Computer system, 90219-02 compatible with appropriate software
- DC voltmeter, 4.5 digits, Fluke 8060A or equivalent
- Diskette, 90217, Production Test Aids (P/N 063-0609-xx)
- Diskette, 90217 RAM code, current version
- AA type batteries, 3 ea.
- Cable, IR communications, 90217/90207 (P/N 012-0097-02 or later)
- Calibration test setup (refer to page 4-7)
- Screwdriver, 0.05-inch flat blade, insulated handle
- Screwdriver, Phillips, #0 tip
- Screwdriver, Phillips, #1 tip
- Hemostats
- Magnet

Preparation

- Carefully read through these procedures
- Connect the communications cable to the IR port on the 90217
- Load the Production Test Aids software (Xmain.exe) onto the hard disk of the computer system
- Copy the 90217 RAM code into same directory as Xmain.exe program (Production Test Aids software)
- Ensure that charged batteries (3) are installed into the 90217 monitor

Note:

A voltimeter may be used to check battery condition.

NiCad: 1.30 V = full charge (> 1.25 V minimum)

Alkaline: 1.56 V = full charge (> 1.50 V minimum)

Pre-calibration Checks

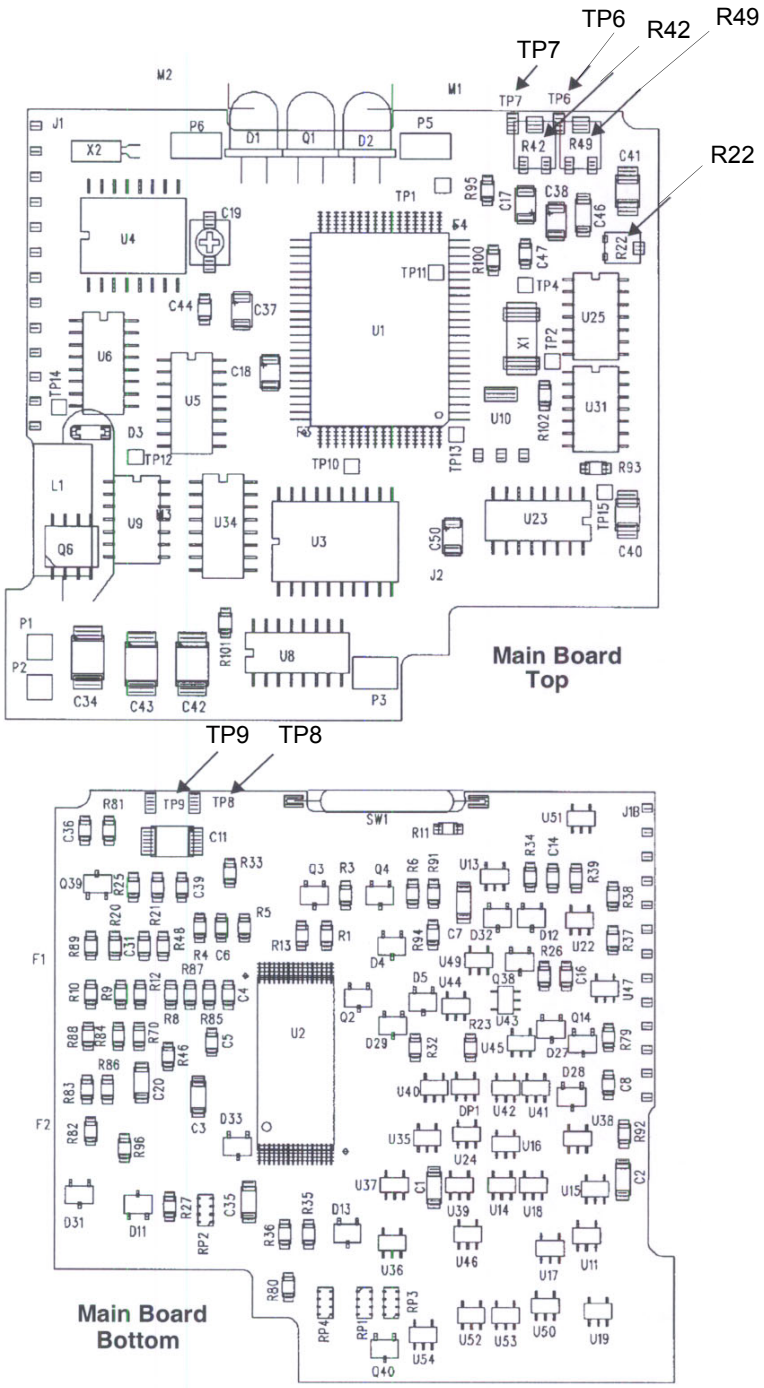
1 Remove the back cover on the 90217 monitor.

2 Measure the +4.608 volt reference (TP7) on the Main Board.

a Place a magnet near the IR port on the monitor (or connect the IR cable to the port).

b Switch ON the monitor power.

c Connect a DC voltmeter positive lead to TP7 (+4.608) and the negative lead to TP9 (ground). Refer to the following figures for test point locations.



d Verify that TP7 is between +4.605 and +4.611 volts. If not, readjust R22 to obtain +4.608 ±0.002 V.

3 Measure the +5 V supply (TP6) on the Main Board.

a Connect a DC voltmeter with the positive test lead on TP6 (+5 volts) and the negative on TP9 (ground).

b Verify that TP6 measures between +5.05 and +4.95 volts. If not, adjust R78 on the power board until TP6 measures +5.0 ±0.01 volts.

4 Replace the back cover of the 90217 case (removed in step 1).

Calibration Setup

1 Verify that the IR cable is connected to the serial port on the computer system and to the IR port on the back of the 90217 (when communicating correctly, the monitor will display **9999** and occasionally **2999**).

2 Start the "X" program by changing to the subdirectory where the file XMAIN.exe is located and typing: **X** and pressing the **Enter** key.

3 When the computer establishes contact with the monitor, the Test Utility **Main Menu** appears:

```
1. SYSTEM CONFIGURATION
2. MAKE CONTACT WITH MONITOR.

ENTER SELECTION__
```

From this menu, select **MAKE CONTACT WITH MONITOR** by typing the item number appearing to the left of this menu item (**2**) and pressing **Enter**.

Verify that the screen clears and momentarily displays **SPEED 4 IS ENGAGED** (and other miscellaneous information). If the RAM code is corrupted, the program downloads code.

4 At the conclusion of the above process, the Manufacturing Test Utility **Main Menu** reappears with additional menu items and the monitor's RAM and ROM code version numbers:

```
1. SYSTEM CONFIGURATION
2. INITIALIZE MONITOR.
3. DOWNLOAD 90217 RAM CODE.
4. EXHAUSTIVE MEMORY TEST.
5. SET 90217 GAIN AND OFFSET.
7. SPEAKER TEST.
8. PUMP TEST.
9. HARDWARE OVERPRESSURE TEST.
10. COMMUNICATIONS TEST.
11. MANOMETER MODE.
12. RESET FOR ANOTHER MONITOR.
ENTER SELECTION __

ROM ID = 90217 V 03.02.xx
RAM ID = 90217 V 03.02-xx
```

5 Select **2. INITIALIZE MONITOR**.

6 Verify that the screen displays **ABP RESET SUCCESSFUL** and **CLOCK SUCCESSFULLY SET** and that the **Main Menu** screen again appears.

Pressure Offset and Gain Adjustment

1 Adjust the pressure offset:

a From the **Main Menu**, select **5. SET 90217 GAIN AND OFFSET**.

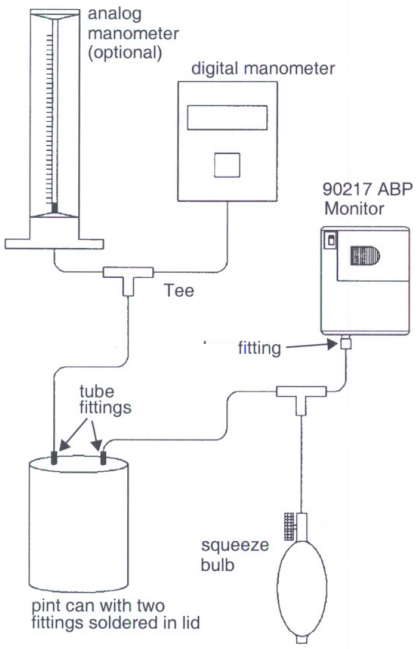
b Verify that the following screen appears:

90217 GAIN AND OFFSET ADJUSTMENT	
1. Adjust offset pot for 00 with hose disconnected. 2. Adjust gain to match manometer at about 200 mmHg. 3. Due to interaction, repeat 1 and 2 as needed.	
0.1 mmHg	20 counts

c Verify that the mmHg value appearing at the bottom of the screen reads **0.0 ±0.3**. If not, readjust R49 (pressure offset adjustment) until the mmHg value at the bottom of the screen reads **0.0 ±0.1**.

2 Adjust the pressure gain:

a Connect the sphygmomanometer test configuration to the 90217 monitor:



Calibration Test Setup

b Manually pump system pressure to 195 mmHg.

c Verify that the mmHg value appearing at the bottom of the screen reads **195 ±1.0**. If not, adjust R42 (pressure gain adjustment) until the mmHg value reads **195**.

3 Repeat the offset and gain adjustments until no further adjustments are required to produce the correct values.

Pressure Leakage

1. In the sphygmomanometer test configuration, use a hemostat to clamp the hose going to the 90217 and pump the pressure to 280 mmHg ±4.
2. Clamp the hose going to the squeeze bulb with a hemostat and measure the leakage rate (system leakage).
3. Unclamp the hoses going to the 90217 and squeeze bulb.
4. Repump the system to 280 mmHg, reclamp the hose to the bulb and measure the leakage rate (90217 + system leakage).
5. Subtract the first leakage rate (system leakage) from the second leakage rate (90217 + system leakage).
6. Verify that the pressure drop due to 90217 leakage is <6 mmHg per minute, or <4 mmHg per 4 minutes for 90217-41 (Japan) and <4 mmHg per 2 minutes for 90217-32 units (German).
7. Release the system pressure.

Over-Pressure Checks

1. Press the **Esc** key (the **Main Menu** should return).
2. From the **Main Menu**, select **9. HARDWARE OVERPRESSURE TEST**.
3. Verify that the pump starts and continues to run, building pressure until the hardware over-pressure limit is achieved. Verify that the pressure value appearing at the bottom of the screen falls between 285 and 295 mmHg.
4. Press the **Esc** key.

Over-Pressure Relief Valve Check

1. Power OFF the 90217.
2. Disable the hardware over-pressure circuit by connecting TP8 (over-pressure test point) to TP9 (ground) using a small patch cable.
3. Power ON the 90217.
4. From the initial menu, select **2. MAKE CONTACT WITH MONITOR**.
5. When the **Main Menu** appears, select **9. HARDWARE OVERPRESSURE TEST**.
6. The pressure will increase until it opens the over-pressure relief valve. When the pressure increase levels off at a rate of 3 sec/mmHg, check the pressure displayed on the manometer and verify that it falls between 300 and 325 mmHg.
7. Remove the jumper between TP8 and TP9.
8. Power OFF the 90217.
9. Press the **Esc** key.
10. Power ON the 90217.

Hardware Safety Timers Check

1. From the **Main Menu**, select **2. MAKE CONTACT WITH MONITOR**.
2. When the **Main Menu** appears, select **11. MANOMETER MODE**.
3. Manually pump up the system pressure to 165 mmHg ±10.
4. Remove the IR cable and start the timer.
5. Exit the X program and return to DOS by pressing **Esc** two times.
6. When the valve opens (pressure decreases rapidly), verify that the elapsed time is between 178 and 182 seconds (fault holdoff timer).
7. When the 90217 display changes from showing pressure to showing the software version, verify that the elapsed time falls between 194 and 198 seconds (watch dog timer).
8. Remove the test setup and restore any 90217 screws previously removed.

Operational Verification

These procedures verify that the 90217 ABP monitor's blood pressure readings are consistent with design standards.

Note:
These procedures use the DynaTech Nevada CuffLink Blood Pressure Simulator. If you are using a different simulator, refer to its operator's manual and determine equivalent tests. Refer to the end of this Maintenance chapter for instructions on using the CuffLink simulator in the automatic or the manual mode.

Equipment Required

- DynaTech Nevada CuffLink Noninvasive Blood Pressure Analyzer (and equivalent) and associated tubing, manuals, fittings (software version 2.0 or higher is required)
- 1/8 inch I. D. tubing (P/N 162-0019-00 or equivalent)
- Adult cuff (P/N 016-0264-00 or equivalent)
- Luer connector (P/N 103-0008-00)

Blood Pressure Simulator Preparation

1. Turn ON the CuffLink simulator and allow it to warm up for a minimum of 15 minutes.
2. Verify that the calibration sticker is current. If it is not, the simulator will need to be calibrated by the manufacturer or its authorized service facility.
3. Check the zero pressure by selecting **ADAMS Adult** from **SelectBp** in the **Main Menu**.
4. Press **ENT**.
5. Press **F5** to zero the pressure.
6. Press **Esc** to return to the **Main Menu**.

7 Perform a leak rate check on the blood pressure simulator and associated tubing as follows:

- **a** While in the **Main Menu**, move the cursor to **Press** and select **Leak Test** by pressing **ENT**.
- **b** Connect a squeeze bulb to the hose, which will connect directly to the unit under test.
- **c** Pump up the system pressure to approximately 170 mmHg.
- **d** Wait 10 seconds for the pressure to stabilize.
- **e** Press the **START** (F1) key on the CuffLink simulator and wait one minute while the leak rate is measured.
- **f** At the end of the minute, the leak rate will appear on the CuffLink display.
- **g** If the leak rate is greater than 10 mmHg/min, retighten all external hose connections and repeat the test. If the system continues to fail, isolate each length of tubing to locate and repair the source of the leak.
- **h** Press the **Esc** key to return to the **Main Menu**.

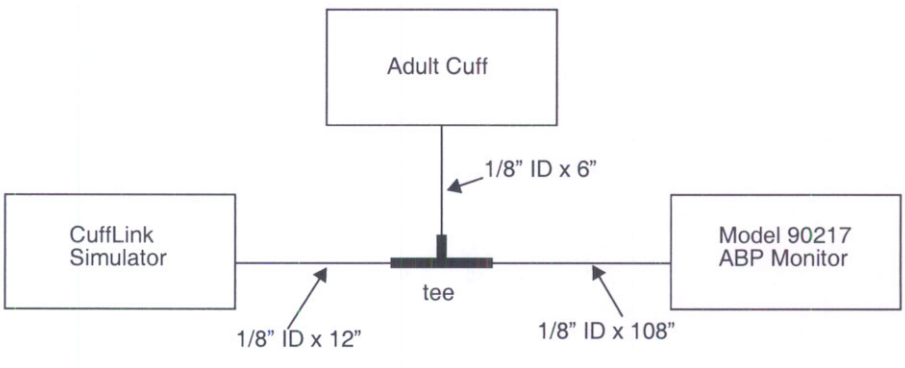
90217 Test Preparation

1 Set up the ABP monitor by connecting it to the CuffLink.

2 Refer to the table below for a list of systolic/diastolic/heart rate settings to be performed on the 90217 monitor:

Pressure	Setting	Range
Systolic	60	52 to 60
Diastolic	30	26 to 33
Heart Rate	40	
Systolic	100	91 to 103
Diastolic	65	60 to 70
Heart Rate	60	
Systolic	120	111 to 124
Diastolic	80	74 to 88
Heart Rate	80	
Systolic	150	143 to 161
Diastolic	100	92 to 108
Heart Rate	120	
Systolic	200	196 to 218
Diastolic	150	142 to 158
Heart Rate	120	
Systolic	255	253 to 277
Diastolic	195	185 to 205
Heart Rate	120	

3 Connect the 90217 to the simulator:



4 Move the CuffLink cursor to **SelectBp** and press the **ENT** key to select **ADAMS Adult**.

5 Press the **F2** key (AdjEnv) and verify that the gain is at 100%. If it is not, adjust it using the arrow keys. At the same time, verify that **OFFSET** and/or **SHIFT** are at 0.

6 Press the **ENT** key.

7 Press the **Esc** key to return to the **Main Menu**.

8 Move the cursor to **AUTO** using the arrow keys and select **Execute** using the **ENT** key.

9 Press the **F1** key to select **ADULT** readings.

10 Zero the pressure by pressing the **F5** key.

11 Press the **Esc** key until the first pressure simulation reading is displayed on the CuffLink.

12 Press the **START/STOP** button on the ABP monitor to start the reading.

Note:

The CuffLink simulator may automatically change to the next blood pressure setting when the current reading is complete. If you must repeat a reading, press the Esc key repeatedly until the ADULT INFANT menu is shown at the bottom of the screen. Press the F1 key to select ADULT readings and then use the Esc key to increment to the reading desired.

13 Repeatedly press the **START/STOP** button on the 90217 to sequence through the list of blood pressures simulated by the CuffLink.

14 At the end of the readings, verify that the systolic and diastolic readings are within given ranges provided in step #2.

Note:

If the readings are out of range, retest the ABP monitor at the same setting. If it still fails, check all hose connections, perform the leak test as described in the beginning of these procedures, and check the gain settings on the simulator. If all this fails, refer to Troubleshooting on page 5-1.

CuffLink Manual Operation

The following steps outline the manual selection of simulated blood pressures and heart rates. These may be used to repeat a reading which was out of range or produced no reading.

1. When the CuffLink is warmed up, move the cursor to the **SelectBp** option of the **Main Menu** and **ADAMS Adult**. Press the **ENT** key to make a selection.
2. Press the **F2** key and verify that the gain is set to 100%. At the same time, verify that the **SHIFT** and/or **OFFSET** are at 0. Press the **ENT** key.
3. Press the **F1** key to move to the **Heart Rate** menu. Use the arrow keys to move the cursor to the desired heart rate. Press the **ENT** key to make a selection.
4. Use the arrow keys to move the cursor to the desired blood pressure and press the **ENT** key.
5. The CuffLink is ready to simulate the selected heart rate and pressure. Press the **START/STOP** button on the monitor to begin.

CuffLink Automatic Operation

Use the following procedure to set or change the automatic sequences stored in the CuffLink:

1. Move the cursor to the **Auto** option of the **Main Menu** and select **Utility** by pressing the **ENT** key.
2. Use the arrow keys to move the cursor to the **EDIT** box. Select sequences to edit and press the appropriate button (F1, F2, F3, etc.). **F1** is assigned to **ADULT**. In the first screen, answer YES to the Pop-OFF test and NO for the rest. The second and third screens list the sequence of blood pressures and heart rates. Use the **arrow keys** to move around the list and use the **F4** and **F5** keys to change the settings. Set **CYCLES** for each blood pressure reading. When finished making changes, press F3 (STORE) to end the edit session.
3. Use the **arrow keys** to move the cursor to the **NAME** box. Select the sequence to be named and press the appropriate button (F1, F2, F3, etc.). Use the **arrow keys** to move to each character and use the **UP** and **DOWN** arrow keys to change the character. When complete, press **ENT** to end the edit.

Manifold Kit - P/N 050-0110-xx

Note:

- *Manifold kit (P/N 050-0110-**00**) is used for equipment that has a luer lock connector.*
- *Manifold kit (P/N 050-0110-**01**) is used for equipment with a quick-disconnect connector.*

To replace the manifold in the 90217 monitor:

1. Disassemble the 90217 ABP Monitor and remove the 672-0171-xx assembly. Separate the manifold from the rest of the assembly by cutting through the 176-0279-00 four-conductor flexstrip cable. Refer to *Disassembly Procedures* on page 4-15.
2. Unsolder the remaining section of flexstrip from the 672-0171-xx assembly and clear the holes of solder.
3. From the back (non-display) side of the display board, insert the leads from the new flexstrip. They are pre-attached to the manifold and should fit into the cleared holes in the old assembly. Do not bend or stress the new flexstrip any more than necessary during replacement.
4. Ensure that the flexstrip is squarely aligned with the display board and fully seated. Solder the four leads in place and trim excess lead length.
5. Install the 672-0171-xx assembly back into the case.
6. Perform a full monitor calibration. Refer to *Calibration Procedures* on page 4-4.
7. Reassemble the 90217 monitor.

Disassembly Procedures

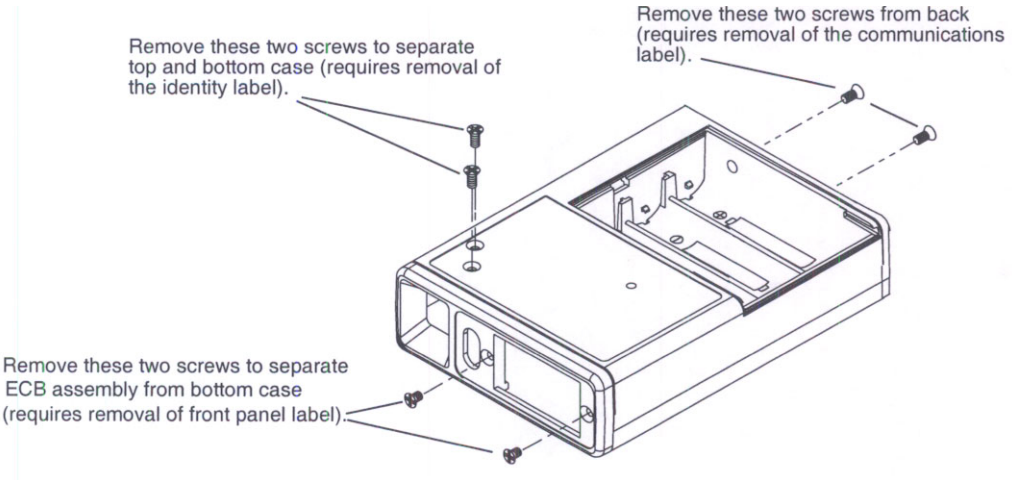
Caution **Observe precautions for handling electrostatic-sensitive devices!**

Note:

- *Never touch electrostatic-sensitive electronic components without following proper antistatic procedures, including the use of an ESD wrist band and mat. An electrostatic discharge from your fingers can permanently damage electronic components.*
- *All static-sensitive electronic components are packaged in static-shielding bags. Retain this bag for repackaging the component should you need to store it or return it to Spacelabs Medical for any reason.*

To open the monitor and access its internal components:

1. Remove the Communications label from the back of the unit (refer to *Parts* on page 6-1 of this manual for replacement part number) and remove the two screws that are exposed (see below).
2. Remove the identify label on top of the unit (see illustration below) and remove the two exposed screws to separate the top and bottom case pieces.



To separate the ECB assembly from the bottom case half:

1. Remove the front panel label from the unit (refer to *Parts* on page 6-1 of this manual for replacement part number) and expose the two screws holding the ECB assembly.
2. Remove these two screws (see previous illustration) and separate the ECB assembly from the lower half of the case.

Troubleshooting

Contents

If monitor problems develop, use the information provided in this chapter as a problem solving guide.

Monitor Event Codes

The 90217 ABP Monitor displays a two-digit event code whenever it is unable to successfully complete a blood pressure measurement. This event code appears as the last digits on the monitor display and is preceded by the letters EC (for example, in the displayed event code EC01, 01 is the event code).

The following list contains a brief description of event codes, which can appear:

EC03 Patient cancel.

EC04 Out of time for measurement. NO time to collect additional data but enough time to evaluate data already collected. Evaluation did not produce a valid reading.

EC05 Individual result corrupted.

EC10 Hung 20 seconds at a bleed step.

EC11 Did not pump high enough. Failed to inflate cuff above systole.

EC13 Reset of Office Check mode.

EC15 Bad checksum in ROM.

EC16 Low battery detected before cuff measurement.

EC18 Too few entries in table to perform analysis.

EC20 Pulse pressure too small. Diastole is greater than historical diastole +20 and there are large oscillometric entries at cuff pressures below diastole which indicate that diastole might be lower.

EC25 Bad checksum in RAM containing code. Initialize monitor to download correct code.

EC28 Diastole greater than 200 mmHg.

EC30 Software could not track changes in oscillometric activity.

EC32 Software overpressure.

EC38 Pulse pressure equals 16 mmHg or less.

EC39 Oscillometric (input) queue overflow.

EC40 No non-discarded entries at lower cuff pressures but within 16 mmHg of systole.

EC42 No cuff attached.

EC45 Illegal bleed size. Not between 4 and 8 mm.

EC48 Pulse pressure is less than historical pulse pressure minus 20 and many pulses failed either screen or failed match.

EC50 No non-discarded entries at higher cuff pressures but within 16 mmHg of diastole.

EC52 Kinked hose.

EC55 Unexpected loss of power. User may have turned power switch OFF during a reading.

EC58 Diastole is less than historical diastole minus 15 and many pulses failed either screen or failed match.

EC62 Loose cuff. Reached 25 mmHg but not target pressure. Cuff may not be attached.

EC69 Too few entries to calculate heart rate.

EC70 Excessive motion at highest cuff pressures.

EC79 Partially clogged bleed line. All blood pressure attempts are inhibited. Attempts can be enabled by turning power switch OFF then ON again.

EC80 Pulse pressure too small. Many pulses failed either the screening or the matching criteria and one of the following: (a) there is an oscillometric entry at a cuff pressure higher than systole whose amplitude is above the level defining systole, suggesting that systole might be higher; (b) there is an oscillometric entry at cuff pressure below diastole whose amplitude is above the level defining diastole, suggesting that diastole might be lower.

EC85 Bad clock.

EC90 Excessive motion throughout the measurement. Three out of five entries were rejected.

EC95 Cuff pressure baseline out of bounds. Initializing the monitor resets the cuff pressure.

EC99 Unexpected or Contradictory Data.

The following codes may also appear on the monitor display:

LLL Main batteries (3 AA cells) are low and do not have sufficient power to operate the pump and complete a measurement. No retry attempt is made following an LLL message.

FULL The monitor contains 240 readings and cannot store any more.

Base Station Report Event Codes

The following list contains the extended event codes, which may appear in a blood pressure report. The extended event code digit appears in the first (tens) digit position (for example, 11). The list is grouped according to the monitor event code (if applicable), which would be displayed at the time of the event. The codes are printed as a numeric value in the systolic column with all other columns printing zero.

Monitor displays -- EC00

Base Station report prints:

10 Measurement aborted as the result of excess movement artifact. Frequent “10” messages may indicate an air leak.

20 A) A very large number of movement artifacts.
B) Heart rate arrhythmia.

30 A) Movement artifact at mean arterial pressure.
B) Heart rate arrhythmia.

40 A) Movement artifact at systole.
B) Heart rate arrhythmia.

50 A) Movement artifact at diastole.
B) Heart rate arrhythmia.

Monitor displays -- EC01

Base Station report prints:

11 Did not pump above the mean arterial pressure.

21 Did not pump above the systolic pressure.

Monitor displays -- EC02

Base station report prints:

12 Did not reach initial cuff pressure. The cuff may have been improperly applied or there may be an air leak.

22 Overpressure.

32 Overpressure.

42 No cuff attached.

52 Kinked hose.

62 Cuff applied too loosely.

72 Kinked hose.

82 Kinked hose.

Monitor displays -- EC03

Base station report prints:

03 Patient canceled measurement by pressing monitor’s START/STOP button.

Monitor displays -- EC04

Base Station report prints:

04 Measurement not completed within 110 seconds. Occasional EC04 messages may result from excessive patient movement. Frequent EC04 messages would either indicate an improperly placed cuff or a monitor malfunction, which requires service.

Monitor displays -- EC05

Base Station report prints:

15 Equipment malfunction. Return it to Spacelabs Medical for service.

25 Unit failed to initialize. Please re-initialize.

35 At least one of the blood pressure or time readings obtained before the event code is erroneous. Interpret all readings with caution.

55 A) Measurement aborted because cuff pressure was too high.
B) Measurement aborted because measurement has taken longer than two minutes to complete.

65 Equipment malfunction. Return unit for service.

75 Equipment malfunction. Return unit for service.

85 Equipment malfunction. Return unit for service.

95 Cuff pressure baseline out of bounds.

Monitor displays -- LLL

Base Station report prints:

16 Low battery prior to start of measurement.

26 Low main battery after measurement started.

Monitor displays -- EC08

Base Station report prints:

18 Too few data entries to accurately determine blood pressure.

28 Diastole above 200 mmHg.

38 Pulse pressure less than 16 mmHg.

Monitor displays -- EC09

Base Station report prints:

19 Hardware fault (valve open with pump turned ON).

29 Diastolic pressure value cannot be obtained from the data available.

39 Systolic pressure value cannot be obtained from the data available.

49 Mean arterial pressure value cannot be obtained from the data available.

59 Heart rate value cannot be obtained from the data available.

69 Heart rate value cannot be obtained from the data available.

Problem Solving Checklist

Use this table to diagnose a monitor problem:

Problem	Possible Cause	Solution
Modem indicators are incorrect.	Modem switch settings are incorrect.	
Monitor display is incorrect.	No data was transferred.	Check modem cable for tight connection.
Only the last digit to the right changes when attempting to communicate.	Data being received fails the CRC test and is declared corrupt.	Check communications cable for tight connections. If it is loose and a bright external light is present, the light may be corrupting the data.
	Data is not retained.	Replace backup battery.
	Power is low or not there.	Check the batteries for correct polarity and a full charge. If needed, replace or recharge the batteries.
	Can be one of the following: time-out, no reading due to air leak in the system, improper cuff size, or cuff not properly attached to the monitor.	Isolate cause and correct.
	If using a modem, phone line is bad.	Have phone company check out line.
	If using a modem, phone system is incorrectly configured.	Verify modem configuration with the phone company and with Spacelabs Medical Technical Support.
Monitor displays “LLL” and alarm sounds.	Main battery is low.	Turn OFF monitor immediately. Replace batteries to continue monitoring.
Cuff is too tight.	Cuff placed on the patient too tightly.	Reposition the cuff.
	The air pump stayed ON too long.	Return the unit to Spacelabs Medical for service.
Cuff is too loose when inflated.	Cuff is placed on the patient too loosely.	Reposition the cuff.
	Air pump is not staying ON long enough.	Return the unit to Spacelabs Medical for service.

Contents

90217 Field Replaceable Parts Lists

Assemblies

Description	Part Number
Manifold Assembly	650-0399-xx
ECB PCBA	672-0171-xx
Pump Assembly	119-0060-xx

Accessories

Table 1: Standard Accessories

Description	Part Number
Carrying Pouch	016-0340-xx
Strap	016-0262-xx
Belt	016-0080-xx
Calibration Kit	016-0040-xx
Garment Clip	344-0008-00A
Battery Set (3 AA alkaline cells)	146-5011-xx
Patient Diary	000-0027-xx
Operations Manual	070-0137-xx
Manifold Kit (for units with Luer-Lock connectors)	050-0110-00
Manifold Kit (for units with Quick-disconnect connectors)	050-0110-01

Table 2: Cuff Accessories

Description	Limb Circumference	Part Number Quick-Disconnect	Part Number Luer-Lock
Pediatric Cuff	12 to 20 cm	015-0118-01Q	015-0118-01
Adult Cuff	17 to 26 cm	015-0067-01Q	015-0067-01
Adult Cuff	24 to 32 cm	015-0068-02Q	015-0068-02
Large Adult Cuff	32 to 42 cm	016-0077-01Q	016-0077-01
Extra-large Adult Cuff	38 to 50 cm	016-0109-01Q	016-0109-01

Table 3: Optional Accessories

Accessories	Part Number
Cuff Support Harness	015-0070-xx
Service Manual	070-0502-xx
Quick-disconnect Coupling (to convert Luer cuffs to Quick-disconnect)	712-0794-00
Male Quick-disconnect to Luer Adapter (to adapt Luer monitor to Quick-disconnect cuff)	712-0773-00

Labels

Description **Part Number**

Domestic

Label, Front Panel 334-1098-00

Label, Communications 334-0828-00

Label, Operating Instructions 334-0829-00

Label, ID, Serial Number 334-0922-00

International English

Label, Front Panel 334-1098-00

Label, Communications 334-0828-00

Label, Operating Instructions 334-0829-00

Label, ID, Serial Number 334-0922-00

French

Label, Front Panel 334-1098-00

Label, Communications 334-1112-00

Label, Operating Instructions 334-1107-00
Label, ID, Serial Number 334-0922-00

German

Label, Front Panel 334-1098-00
Label, Communications 334-1111-00
Label, Operating Instructions 334-1106-00
Label, ID, Serial Number 334-0922-00

Spanish

Label, Front Panel 334-1098-00
Label, Communications 334-1109-00
Label, Operating Instructions 334-1104-00
Label, ID, Serial Number 334-0922-00

Italian

Label, Front Panel 334-1098-00
Label, Communications 334-1110-00
Label, Operating Instructions 334-1105-00
Label, ID, Serial Number 334-0922-00

Japan

Label, Front Panel 334-1098-00
Label, Communications 334-0828-00
Label, Operating Instructions 334-0829-00
Label, ID, Serial Number 334-0922-00

Service Kits

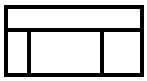
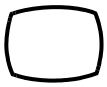
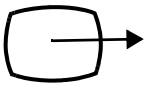
Manifold Kit, (for non-Q Option) 050-0110-00
Manifold Kit, (for Q-Option) 050-0110-01

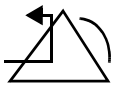
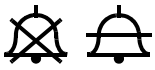
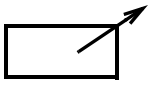
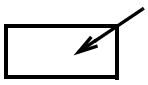
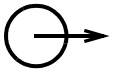
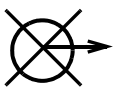
Drawings

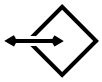
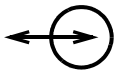
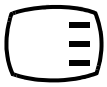
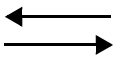
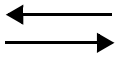
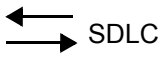
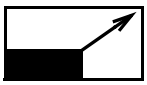
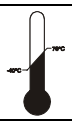
Title	Part Number	Drawing #	# of Pages
90217 Assembly	650-0398-00	1	2
90217 ECB Assembly	672-0171-01	2	1

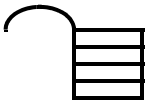
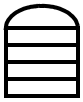
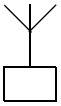
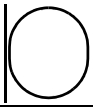
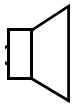
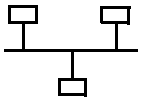
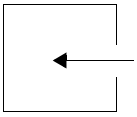
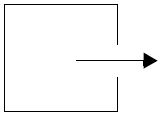
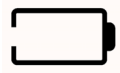
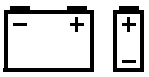
Symbols

The following list of international and safety symbols describes all symbols used on Spacelabs Medical products. No one product contains every symbol.

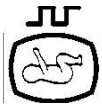
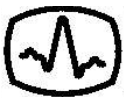
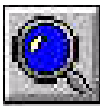
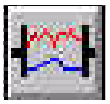
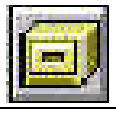
Symbol	Description	Symbol	Description
	HELP Key		Keyboard Connection
	SPECIAL FUNCTIONS Key		Mouse connection
	RECORD Key		START/STOP Key
	NORMAL SCREEN Key		START/STOP
	MONITOR SETUP Key		STOP or CANCEL Key
	ALARMS Key		CONTINUE Key
	PREVIOUS MENU Key		ENTER Key
	ON — Power Connection to Mains		OFF — Power Disconnection from Mains
	ON Position for Push Button Power Switch		OFF Position for Push Button Power Switch
	On Direction		ON/OFF
	Television; Video Display		Video Output
	ON — Part of the Instrument Only		OFF — Part of the Instrument Only

Symbol	Description	Symbol	Description
	Stand-by		STAND-BY Key
	PAUSE or INTERRUPT		Slow Run
	Reset		Power Indicator LED
	Alarm		Temporary Shut Off of Alarm Tone or Screen Indicators
	Indicator — Remote Control		Indicator — Local Control
	PRINT REPORT Key		Indicator — Out of Paper
	Partial ON/OFF		Recorder Paper
	Normal Screen		Return to Prior Menu
	Clock/Time Setting Key		TREND/TIMER Key
?	HELP (Explain Prior Screen) Key		Keypad
	Activate Recorder for Graphics		Indoor Use Only
	START (NIBP) Key		Auto Mode (NIBP)
	Output		No Output (Terminated)

Symbol	Description	Symbol	Description
	Data Input/Output		Input/Output
	Input		Reset
	Menu Keys		Waveform/Parameter Keys
	Monitor Setup Select Program Options		Set Initial Conditions Menu
	Access Special Function Menu		Return Unit to Monitor Mode
	Serial Port 1		Serial Port 2
	External marker push button connection		SDLC Port
	Arterial Pulse		Electrocardiograph or Defibrillator Synchronization
	Gas Exhaust		Foot Switch
	Enlarge, Zoom		Delete
	PCMCIA Card		Event
	Keep Dry		Fragile; handle with care
	Environmental Shipping/Storage Altitude Limitations		This Way Up
	Environmental Shipping/Storage Temperature Limitations		Environmental Shipping/Storage Humidity Limitations

Symbol	Description	Symbol	Description
	Open Padlock		Closed Padlock
	Down Arrow		Up Arrow
	Hard Drive		Power Indicator LED
	Antenna		Mermaid Connector
	Microphone		Omnidirectional Microphone
	Audio Output, Speaker		Activate Telemetry Recorder
	Network Connection		Universal Serial Bus
	Gas Sampling Port		Gas Return Port
	Remote Alarm; Nurse Alert		Nurse Call
	Battery Status		Low Battery
	Battery Replace only with the appropriate battery.		Replace only with the appropriate battery. (+ / - signs may be reversed)
	All batteries should be disposed of properly to protect the environment. Lithium batteries should be fully discharged before disposal. Batteries such as lead-acid (Pb) and nickel-cadmium (Ni-Cd) must be recycled. Please follow your internal procedures and or local (provincial) laws regarding disposal or recycling.		Caution - hazardous voltages. To reduce risk of electric shock, do not remove the cover or back. Refer servicing to a qualified field service engineer (U.S.A.). DANGER - High Voltage (International)

Symbol	Description	Symbol	Description
	Protective Earth Ground		Functional Earth Ground
	Replace Fuse Only as Marked		Fuse
	Power supply jack polarity. (+ / - signs may be reversed)		Equipotentiality Terminal
	Alternating Current		Direct Current
	Both Direct and Alternating Current		AC/DC Input
A	Amperes	Hz	Hertz
V	Volts	W	Watts
	IEC 601-1 Type B equipment. The unit displaying this symbol contains an adequate degree of protection against electric shock.		Class II Equipment
	IEC 601-1 Type BF equipment which is defibrillator-proof. The unit displaying this symbol contains an F-type isolated (floating) patient-applied part which contains an adequate degree of protection against electric shock, and is defibrillator-proof.		IEC 601-1 Type BF equipment. The unit displaying this symbol contains an F-type isolated (floating) patient-applied part providing an adequate degree of protection against electric shock.
	IEC 601-1 Type CF equipment. The unit displaying this symbol contains an F-type isolated (floating) patient-applied part providing a high degree of protection against electric shock, and is defibrillator-proof.		IEC 601-1 Type CF equipment. The unit displaying this symbol contains an F-type isolated (floating) patient-applied part providing a high degree of protection against electric shock.
	Loop Filter		Adult NIBP

Symbol	Description	Symbol	Description
	ETL Laboratory Approved		Canadian Standards Association Approved
	Risk of Explosion if Used in the Presence of Flammable Anesthetics		Operates on Non-Harmonized Radio Frequencies in Europe
Note	Note		Attention - Consult Operations or Service Manual for Description
WARNING	Warning About Potential Danger to Human Beings	**CAUTION**	Caution About Potential Danger to a Device
	Noninvasive Blood Pressure (NIBP), Neonate		Fetal Monitor Connection (Analog)
	Fetal Monitor Connection RS232 (Digital)		Physiological Monitor Connection RS232 (Digital)
	Happy Face		Sad Face
	Magnifying Glass		Compression
	File Cabinet		List of Rooms
	Arrows		Printer
	Recycle		Service Message
	Radio transmitting device; elevated levels of non-ionizing radiation		

Abbreviations used as symbols are shown below.

Symbol	Description	Symbol	Description
1 - 32	Access Codes 1 Through 32	**AIR**	Air
ANT 1 **ANT 2**	Diversity Antenna System 1 Diversity Antenna System 2	**Arr1** **ArrNet2**	Arrhythmia Net 1 Arrhythmia Net 2
CH **ch**	EEG, EMG, or ECG Channel EEG Channels - CH1, CH2, CH3, CH4 EMG Channel - CH5	**cmH_2O**	Centimeters of Water
C.O. **CO** **co**	Cardiac Output	**DIA** **dia**	Diastolic
ECG **ecg**	Electrocardiogram	**EEG** **eeg**	Electroencephalogram
EMG **emg**	Electromyogram	**ESIS**	Electrosurgical Interference Suppression
EXT	External	**FECG**	Fetal Electrocardiogram
FHR1 **FHR2**	Fetal Heart Rate, Channel 1 Fetal Heart Rate, Channel 2	**GND** **gnd**	Ground
HLO **hlo**	High-Level Output	**Multiview**	Multi-Lead Electrocardiogram
NIBP **nibp**	Noninvasive Blood Pressure	**N_2O**	Nitrous Oxide
O_2	Oxygen	**PRESS** **press** **PRS**	Pressure
RESP **resp**	Respiration	**SDLC**	Synchronous Data Link Control
SPO2 **SpO2** **SpO_2** **SaO_2**	Arterial Oxygen Saturation as Measured by Pulse Oximetry	**SVO2** **$S\underline{v}O2$** **SvO_2**	Mixed Venous Oxygen Saturation

Symbol	Description	Symbol	Description
SYS **sys**	Systolic	**T1** **T2** **T3** **T4**	Temperature 1 Temperature 2 Temperature 3 Temperature 4
TEMP **temp**	Temperature	**UA**	Uterine Activity or Umbilical Artery
VAC	Vacuum Connection		

Appendix A — Electromagnetic Compatibility

Contents

Electromagnetic Emissions

Note:

The 90217 ABP monitor has been tested under laboratory conditions and is suitable for use in all establishments, including domestic establishments and those directly connected to the public low-voltage power supply network that supplies buildings used for domestic purposes. The customer, or user, of the module should ensure that it is used in such an environment.

Emission Test	Compliance	Electromagnetic Environment
RF emissions **CISPR 11**	Group 1 Class B	The ABP monitor uses RF energy only for internal function. Therefore, RF emissions are very low and are not likely to cause any interference in nearby electronic equipment

Electromagnetic Immunity

Note:

The ABP monitor is intended for use in the electromagnetic environment specified below. The customer, or user, of the module should ensure that it is used in such an environment.

Immunity Test	IEC 60601 Test Level	Compliance Level	Electromagnetic Environment
Electrostatic discharge (ESD) **IEC 61000-4-2**	±6 kV contact ±8 kV air	6 kV contact 8 kV air	Floors should be wood, concrete, or ceramic tile. If floors are covered with synthetic material, the relative humidity should be at least 30%.

Frequency Separation Distances

Note:

The ABP monitor is intended for use in an electromagnetic environment in which radiated RF disturbances are controlled. The customer, or user, of the module can help prevent electromagnetic interference by maintaining a minimum distance between portable and mobile RF communications equipment (transmitters) and the module, as recommended below, according to the maximum output power of the communications equipment.

Recommended Separation Distances Between Portable and Mobile RF Communications Equipment and the Monitor (Always evaluate electronic equipment on site before use.)

Immunity Test	IEC 60601 Test Level	Compliance Level	Electromagnetic Environment
Radiated RF **IEC 61000-4-3**	3 V/m 80 MHz to 2.5 GHz	3 V/m 1 kHz sine 80% AM	Portable and mobile RF communications equipment should be used no closer to any part of the monitor, including cables, than the recommended separation distance calculated from the equation applicable to the frequency of the transmitter. **Recommended separation distance:** $d = \left[\frac{3.5}{V_1}\right]\sqrt{P}$ 150 kHz to 80 MHz $d = \left[\frac{3.5}{E_1}\right]\sqrt{P}$ 80 MHz to 800 MHz $d = \left[\frac{7}{E_1}\right]\sqrt{P}$ 800 MHz to 2.5 GHz Where *P* is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer, and *d* is the recommended separation distance in meters (m). Field strengths from fixed RF transmitters, as determined by an electromagnetic site survey,* should be less than the compliance level in each frequency range.**  Interference may occur in the vicinity of equipment marked with the following symbol. IEC 60417-5140: Non-ionizing electromagnetic radiation

* *Field strengths from fixed transmitters, such as base stations for radio (cellular/cordless) telephones and land mobile radios, amateur radio, AM and FM radio broadcast, and TV broadcast cannot be predicted theoretically with accuracy. To assess the electromagnetic environment due to fixed RF transmitters, an electromagnetic site survey should be considered. If the measured field strength in the location in which the monitors are used exceeds the applicable RF compliance level above, the monitors should be observed to verify normal operation. If abnormal performance is observed, additional measures may be necessary, such as reorienting or relocating the monitors.*

** *Over the frequency range 150 kHz to 80 MHz, field strengths should be less than [V_1] V/m.*

Rated Maximum Output Power of Transmitter (watts)	Separation Distance According to Frequency of Transmitter (meters)		
	150 kHz to 80 MHz	80 MHz to 800 MHz	800 MHz to 2.5 GHz
0.01	0.02	0.02	0.04
0.1	0.06	0.06	0.1
1	0.2	0.2	0.4
10	0.6	0.6	1.1
100	1.8	1.8	3.5
Note 1: At 80 MHz and 800 MHz, the separation distance for the higher frequency range applies. **Note 2:** These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects, and people.			